Rheology of vitreous humour and pharmacological substitutes used in the treatment of vitreoretinal pathologies

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Vitreoretinal pathologies are the second leading cause of blindness worldwide. They can be caused by age-related changes in vitreous humour (VH) or as a consequence of some diseases that lead to rheological, biochemical and structural rearrangements. So far, the most effective treatment for these diseases is the injection of a VH substitute in the vitreous cavity. These substances can be used intra-operatively to push a detached retina into its normal position, to restore the volume of the vitreous cavity, and to help surgeons in membrane dissection. The major vitreous substitutes commercially available are silicone oils and perfluorocarbon liquids, but currently there is little information about the rheological properties of these fluids, that are intimately linked to their functionality.

The aim of this work is to compare the rheological properties of the VH and five commercial vitreous substitutes currently used in vitreoretinal surgeries. Six fluids were analysed: VH extracted from New Zealand white rabbit specimen, three silicone oils (RS-Oil1000 and RS-Oil5000, Alchimia and Siluron 2000, Fluoron), two perfluorocarbon liquids (HPF8 and HPF10, Alchimia) and a mixture of silicone oil with perfluorocarbon (Densiron68, Fluoron). Extensional measurements were performed with a capillary break-up extensional rheometer (Haake CaBER1, ThermoElectron) and an in-house extensional rheometer. The steady shear and small amplitude oscillatory shear measurements (SAOS) were performed with a hybrid rheometer (DHR-2, TA Instruments).

Our results show that VH substitutes used for same purpose exhibit significantly different rheological properties between them and when compared with the VH. Vitreous humour shows viscoelastic behaviour and all the pharmacological fluids tested display a Newtonian-like behaviour in steady shear flow with viscosities varying from 0.49 mPa s to 4.57 Pa s, at 37°C.

Keywords: Vitreous Humour, Vitreous Humour substitutes, Rheology.

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